Hot Iron

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Editorial

As I sit here with a blank page in front of me pondering on the world for Construction Club members and the rain continues to pour down I give thanks that I am about 20 feet above sea level! Even the Government has noticed that its been raining for nearly two months and the weather systems are not behaving normally! Though I have not seen any reports in the media, I feel pretty sure that Raynet members have been out and about in Yorkshire and around the Severn Valley helping with communications in the flooded areas. Well done lads and lasses! Increasingly, computing technology is creeping into all branches of communications, especially where the radio conditions are difficult so that the benefits of digital signal processing can be used to advantage. Recently we had a talk at the Yeovil ARC about the new data mode called PSK31 - standing for Phase Shift Keying at 31 bauds or bits per second. There are several free software packages which can be run on quite modest elderly PCs and give outstanding performance under difficult conditions. Less than a watt or so of RF on 20m giving solid (typed text) copy to/from Scandinavia when there was no trace of the audio modulation when listened to on a conventional SSB phone receiver. In part, the ability to recover signals buried very deep in the noise is due to the narrow bandwidth and special Fast Fourier Transform software which actually does a real time spectrum analysis on the audio signals coming from the receiver so that the character recognition software only has to respond to signals in a very narrow bandwidth. The 'occupied' bandwidth is around 30 Hz so many channels can occupy the 2 to 3 Khz normally used for phone SSB signals. Practically, a conventional SSB RX is tuned to the nominal RF frequency and then the software is tuned using the mouse and PC display, to any '30 Hz channel' within the normal RX audio bandwidth. This gives over 50 channels for a single nominal RF! This suggests that there is now a good role for a very simple crystal controlled fixed RF frequency RX and TX but able to work many software channels through audio modulation/demodulation by the computer! I know some of our Club members have experimented with this mode and I should love to hear more about it! I feel a kit coming on!

Kit Developments

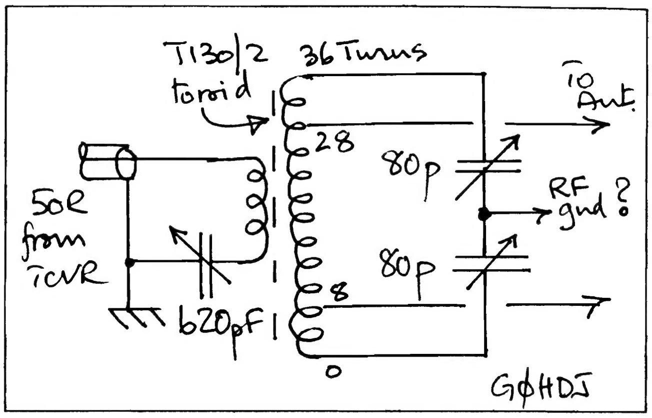
The Bristol is now available after several prototypes have been built. Its quite a rig - in many senses! You can fit plug-in cards for any single or pair of bands for 10 to 160m for CW and SSB operation, or add a band card switch kit for two card positions and hence four bands normally fitted. The Meter kit and digital readout can be added easily. Ex stock - build it over Christmas! Thanks to Andy Howgate, I have developed a speech processor kit. It modulates the audio up to 5 MHz double sideband suppressed carrier, clips it to improve the average to peak qualities of the signal, filters out the harmonics of 5 MHz, and demodulates back to audio. 50 x 80 PCB costing £24. Tim W. G3PCJ

Hot Iron is a quarterly newsletter for radio amateurs interested in building equipment. It is published by Tim Walford G3PCJ for members of the **Construction Club**. Articles on simple theory, construction, testing, updates on kits, questions and suggested topics are always wanted. Please send correspondence and membership inquiries to Upton Bridge Farm, Long Sutton, Langport, Somerset, TA10 9NJ. Tel 01458 241224 or e mail walfor@globalnet.co.uk The Walford Electronics website can be seen at www.users.globalnet.co.uk/~walfor Subscriptions are £6 per year for the UK (£8 overseas) from Sept 1st in each year.

Antenna Matching Unit for 40m Doublet

Following from earlier suggestions for his doublet, Craig G0HDJ reports:-

The unit was constructed but did not appear to operate as expected! (What's new!) Events overtook me for a while but last week I got back to thinking about it and went to have a word with the guru - Eric G3GC. He suggested with the aid of his Smith Chart that perhaps another quarter wave length of feeder might sort it out. This was fitted and seems to have done the trick. I have yet to put it into a box so all might turn pear-shaped. Also noticed was that it seemed to have a positive effect on my 40m night time BCI problem which afflicts all rigs.



The final circuit is shown right. I tried it on 30m but it didn't want to know!

Craig also offers the following ***Snippets***. 1. Clean enamel coated wire by dragging it carefully across the teeth of a hacksaw blade - works a treat. 2. Stop keys/keyboards moving about the desk when in use with a little of the material that does the same thing for carpets - almost welds them down!

Letters to the Editor!

'With reference to the question about whether the morse test should be scrapped, my feelings are this. The test should be scrapped, and instead, maybe one should have held a B licence for a certain period of time, before then applying to be upgraded to A. Alternatively, perhaps one should be required to build a simple superhet HF receiver. This could certainly be interesting. Apart from this, I am woefully short on ideas as to what the test should be replaced with, or indeed whether we don't just all become A without further formality. Morse itself should be actively encouraged. It is part of our communications heritage and as such warrants preservation through active use. The beauty of CW is that outstanding results are possible using low power, simple transmitters and transceivers. I am an avid constructor and experimenter, generally on HF. After 28 years in the hobby, all I have to show for it is a class B licence, which obviously makes things difficult. Morse should not be a barrier but a pleasure for those who wish to pursue it. Those who are introduced to the hobby should of course be shown CW in action and encouraged to take an interest in it. David Rowlands G6UEB'

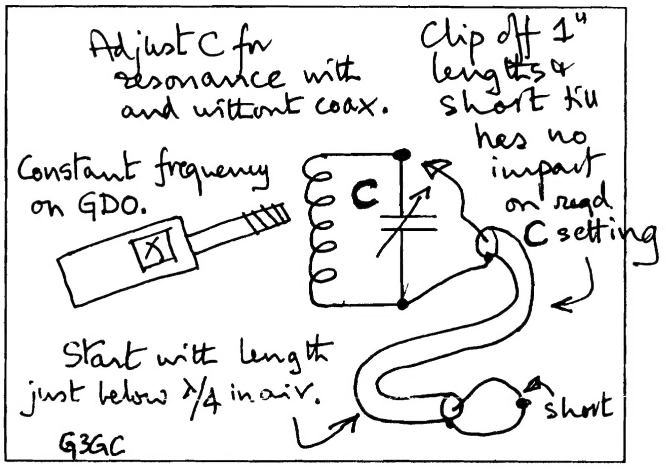
'Some years ago I built a transistor tester using a circuit from the Rad Com Handbook. Although I have successfully checked *npn* and *pnp* transistors for go/nogo, I have never been sure if they were better or worse than they should be - how can one check the parameters or variations between similar devices? Derek Alexander G4GVM'

Answer! Derek continues with several other questions on FETs and asks how he can tell which device should be selected for a particular circuit. The easy answer is that they are often not worth testing! If in doubt chuck them away because new ones are generally now so cheap and a keen constructor should always buy ten if he needs just one! To make an assessment of their individual performance requires some sort of meter which will show (for example) the collector current for a specific base current so indicating the device's current gain. The cost of such an instrument would keep you in new devices for years! Junction FETs like the 2N3819 can be tested by measuring the drain current for zero bias, i.e. gate joined to source. For this device it can range from 2 to 18 mAmps and still be in spec! Assessing MOSFETs like the BS170 and IRF510 is a little harder, often the easiest way is to check that altering the gate DC voltage from about 1 to over 5 volts causes a drain current to flow - bearing in mind that both can pass Amps, use a series drain resistor of 100R to limit the current! Selecting individual devices for someone else's circuit is impractical - you just have to rely on the circuit designer having done his job properly so that the circuit will work with edge of spec devices! That is why there is always some risk in substituting alternatives if you don't have the one specified. Also be aware that some transistors like the BC106/109/182/212 families are often sorted, and sold with different supplementary letters, indicating they are in different gain groups and so circuits may not work with a transistor having a different end letter to that specified. There is no substitute for a good book listing the main device parameters - try old RS and Farnell catalogues.

Measuring the Velocity Factor of Coaxial Cables - by Eric Godfrey, G3GC

In the Summer Issue of Hot Iron I dealt with how to check what the impedance was of an odd length of coaxial cable. This note deals with measuring the velocity factor of a coaxial cable if this is in any doubt. Most velocity factors will fall between 0.67 and unity. The former is the value for solid polythene dielectric and the latter the value for an air only dielectric which of course is mechanically impossible to achieve. However there are some feeders using spiral polythene insulation which have a velocity factor of around 0.96. These are the Heliax cables commonly used at the higher frequencies because of their low loss due to the minimum amount of polythene used in their construction.

So how do we go about measuring the velocity factor? Well we again make use of the fact that the input impedance of a piece of feeder precisely an electrical quarter wave long and shorted at the far end will look like an open circuit, that is to say it will be a very high pure resistance without a reactive component. If such a shorted quarter wave feeder is connected across a resonant circuit fed with RF at a known and stable frequency, and is tuned to resonance by a variable capacity, then there will no change required in the position of the variable capacity to maintain resonance when the short circuited quarter wave is added. When this is achieved, then the physical length of the cable can then be measured and compared with the theoretical length of a quarter wave in air at the frequency in use.



Practically one starts with a length of shorted cable a bit below the theoretical length of the quarter wave *in air* at the frequency in use and then observe how much the variable capacitor has to be moved to regain resonance. An inch or so is then taken off the cable and it is then reconnected across the resonant circuit which is again tuned to resonance. The capacitor will now be nearer its original setting and again the length of the cable under test is reduced. The change in capacitor setting should now be much smaller and by successive cutting and measuring the exact length for no change of the capacitor will be found and the velocity factor may then be calculated from the formula below.

If you have got a good frequency meter then another method is to use a free running oscillator and measure the frequency. Here you adopt the same principal of successively cutting back but this time to maintain the same frequency from the oscillator whether the cable is connected or not. The fact that the frequency may drift a little is of no consequence so long as there is no change between the "on" and "off" measurements and the frequency noted. A variation of this method is to take a piece of the short circuited cable of some convenient physical length and tune the oscillator to the frequency at which there is no change whether the cable is connected or not and again noting the frequency.

Irrespective of what method is adopted, the physical length of the cable is measured and compared with the theoretical length of a quarter wave in air at the frequency in use. The velocity factor is then given by the following formula:-

Velocity Factor = Measured Physical Length / Theoretical Length of a quarter wave in air.

If possible, it is useful to measure the velocity factor before doing the measurement of impedance described previously in the Summer Issue, as a reasonably accurate value for the velocity factor is able to be used rather than relying on a visual estimate.

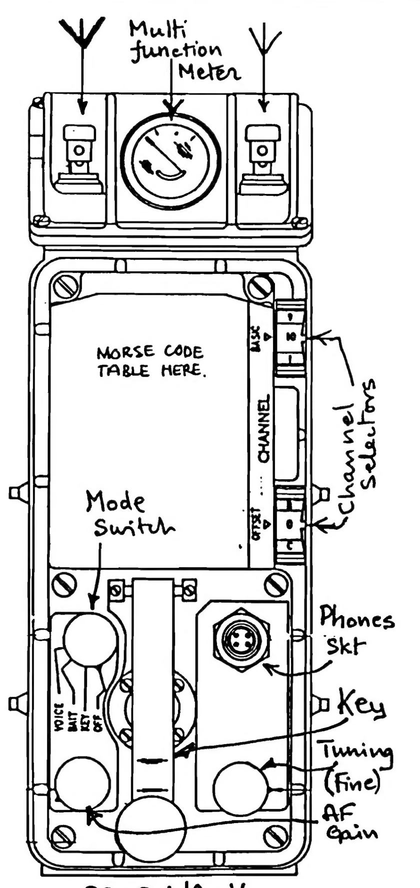
2001 Yeovil QRP Convention Construction Challenge

Get your irons and thinking caps out now! You have to build the most sensitive grid dip type oscillator that you can! It has to cover the 3 to 5 MHz range, not using more than two discrete transistors and must obtain the correct frequency to within 100 KHz. The maximum distance at which the operator calls the 'correct' frequency as the instrument approaches the test resonant circuit will be measured. The resonant circuit will be altered between competitors and the resonant frequency revealed after each entrant has had his attempt to get it correct! Full details from G3CQR.

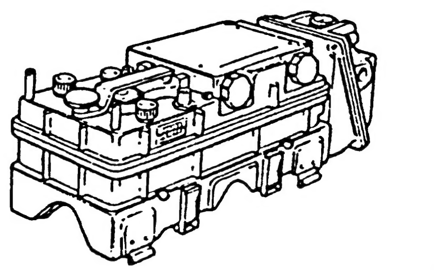
The **Convention** will again be held at Sherborne on **April 22nd** with a full programme of talks, demonstrations, traders and other goodies. There will be a Dinner the evening before open to all by prior booking with G3CQR who can assist with arrangements for accommodation if required.

Military QRP with the PRC316/A-16 - by John Teague G3GTJ

The PRC 316 is a compact transmitter/receiver which was in British Army service from around 1970 to the early nineties. (See drawings right.) It was used for tactical and strategic communications in many theatres and will (I hope) be of interest to Hot Iron readers because the design, by the Signals Research & Development Establishment in the mid-sixties, was based on sound QRP principles from the start. The set was conceived as the solution to the problems of communication with remote patrols operating in jungle, typically in Malaya and Borneo. It had to be lightweight, rugged, have low power consumption and provide reliable communication from near zero range to 500 miles plus in conditions of exceptionally high RF noise levels and the severe attenuation of wet foliage. The requirement was more than achieved by a small kit bag of equipment weighing under 5 Kg. In service the PRC 316 was used on a number of long distance circuits including Belize - Hereford.



PRC316/A-16



The chosen electronic configuration was a 45 channel crystal controlled 5 watt output transmitter allied with a narrow band receiver operating with CW in the frequency range 2 - 7 MHz. A dipole aerial of adjustable length was provided, draped over available scrub and trees by means of a throwing cord. In the jungle the mode of propagation was Near Vertical Incidence Skywave (NVIS). For transmission over long paths greater than 1000 miles the aerial elements could be raised and fed by coaxial feeder. Otherwise the elements connect directly to terminals on the set and are the only signal frequency resonant element in the transmitter PA. The receiver uses double conversion and incorporates a 300 Hz Collins filter. Two banks of crystals are used to generate nine basic channels in the frequency range, each channel variable by two incremental steps of 1.3 KHz above and below its nominal frequency. A further "side-step" crystal at the 455 KHz IF is used to generate the transmitter drive signal. The whole is all-solid state using discrete components powered by a small 16 volt alkaline battery which plugs into the base of the set to provide 20+ hours of operation with 9:1 receive/transmit time. A built in morse key of good quality is fitted and an alternative mode of conventional AM intended mainly for short range ground to air use is available using the combined earphone/microphone.

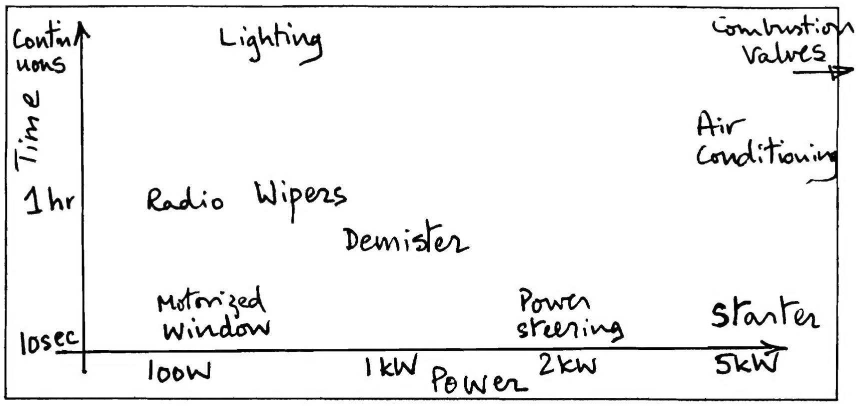
There is no RIT/XIT which means that use on amateur bands with appropriate crystals is possible but not at all convenient. However a VFO drive to replace one of the signal generating crystal oscillators is easily arranged and the actual tuning range of the set covers most of top band and 40m.

The complete radio has overall dimensions of 10 x 4 x 4 inches with an airtight case of aluminium and metallised plastic. It is designed for hard usage and tolerates open or short circuited aerial terminals. Five variants were produced lettered A to E with different channel crystal combinations. All sets except E have one channel in the 80m band at 3710 MHz. A small range of accessories was developed for the PRC 316: an adaptor for connection of an external DC supply; a headset with boom mike and some specialised test equipment. The main attachment was a high speed morse keyer (300 wpm) and its interface unit.

These sets were released onto the open market in the early nineties: the bad news is that relatively few have since entered amateur service. They are sought after and difficult to find although advertised occasionally in the amateur magazines; prices are variable but unlikely to be under £100. I shall be glad to provide any further details to anyone who is interested.

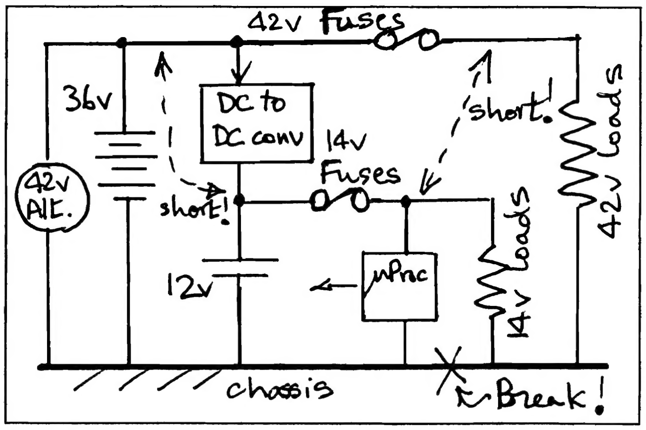
Next Generation Car Electrics

There is a growing awareness that the current widespread use of nominal 12/14 volt lead acid battery systems for cars will not meet future vehicle needs. Already most commercial vehicles use 24 volt systems to crank the larger engines but research into future major mechanical aspects suggest that more electro-mechanical control will bring major advances. The diagram below shows how car power demands have grown as consumers desire more 'performance' - this is without the latest electro-mechanical ideas!



With a 12/14 volt system, supplying 5 kW (even intermittently) implies over 400 Amps which is testing for many batteries so it requires a large alternator if battery storage capacity (and hence weight) is to be kept within reasonable bounds! Obviously to reduce volt drop in cables, they have to be very thick, and so are heavy, difficult to install and require extra large connectors. Designing an electrical or electronic item to work on system voltages which vary from about 10 to 16 under normal conditions is pretty challenging if it is to cost next to nothing, be small, light and work for ever! These considerations all suggest that a higher nominal system voltage would be desirable.

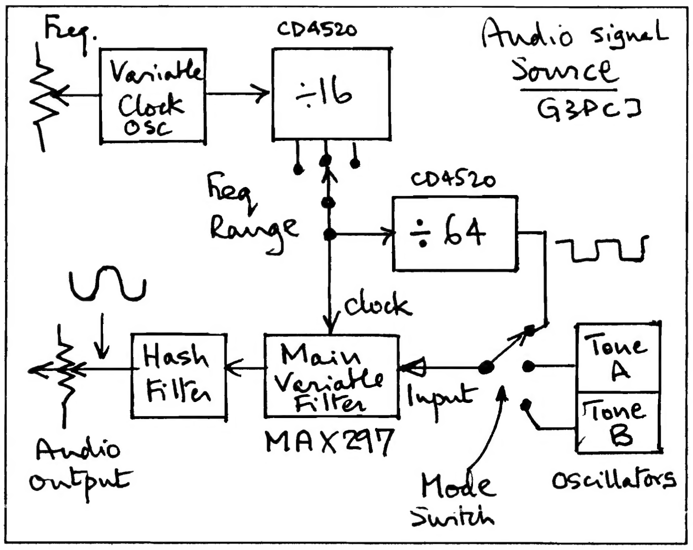
A new 'standard' of 42 volts is emerging based on the charging voltage for a nominal 36 volt battery. This would not only reduce the weight of the wires for the same system functions by some 40% but could support much higher power loads from the newer electro-mechanical devices such as disc brake and steering actuators, and could greatly simplify the drives for conventional engine ancillaries such as water pumps, temperature control systems and even combustion chamber valves! Electric control of the valves might enable a sizeable reduction in necessary starter motor torque as the valves could be held open for negligible compression when first cranking. A higher system voltage would allow the alternator - required to supply the long term average power demand - to supply more power for a given frame size due to the smaller conductors and their lower I^2R dissipation. Using one AC machine permanently 'engaged' for starting with an inverter, and for charging, would reduce weight, cost & eliminate the unreliable starter mechanics. There are many other lesser advantages (e.g. smaller/cheaper electronic switches) with easier recycling of scrap materials becoming more important.



What are the drawbacks? The main snag is the process of technology changeover. Both 14 and 42 volt systems are likely to be needed for some years owing to the lack of higher voltage parts. If a mixed system has to be fitted there are many safety problems - ranging from the dropped screwdriver to what happens in a crash. (See a rough scheme alongside with possible faults indicated.) If multiple voltages are supported by separate batteries, then fusing becomes very difficult and also complicates reverse supply protection. Another approach would use DC to DC converters. Bear in mind that increasing use of micros might require other supply voltages of 5 volts or less! Load dump conditions for the alternator, when the battery (or any other major load) is suddenly disconnected, can lead to very high voltage damaging transients! Other practical problems yet to be overcome include the fragility of light bulbs made for higher voltages. Existing 24 volt bulbs have a 30% shorter life than 12 volt ones! Small motors such as wiper and window actuators may have to get bigger to accommodate the trebling in number of winding turns for the higher voltage since the wire size cannot get much smaller. Much further ahead, hybrid cars may have 50 kW networks with fuel cells operating at 300 to 400 volts! There is much going on in this field! See www.42volt.com for more details. Much of this is has been drawn from a recent IEE article. Tim G3PCJ

Generating low distortion audio sinewaves

Recently, when evaluating the new speech processor kit, I needed a better audio signal source than I had on the test gear shelf. I recalled that Ian Hickman, who writes regular excellent articles in Electronics World, had suggested the use of modern switched capacitor clock tuneable filters for this role. Luckily the Bristol's adjustable audio filter is based on the Maxim 297 clock tuneable elliptic low pass filter so I had suitable devices to hand. This low pass filter has a very sharp cut-off just above the frequency at which the response is 3 dB down - it is over 70 dB down at 1.5 times this -3 dB corner frequency! Consequently it can be used to filter out all the unwanted harmonics of the desired sinewave. Because the corner frequency is tuneable by adjusting the frequency of the driving clock, it can be used to make a high performance tuneable audio source. The crucial -3 dB corner frequency is exactly one fiftieth of the clock frequency applied to the MAX297 - consequently if the clock actually runs at 64 times the desired audio output frequency, then the wanted audio signal will always be a little below the filter's -3 dB corner frequency irrespective of its actual frequency and the harmonics will be negligible. The attenuation of this wanted signal through the filter will always be the same and the output level will then remain constant across the whole tuning range.



The diagram right shows the block diagram of my 'device' covering 200 Hz to 4.8 KHz with the extra oscillators to provide the fixed frequency outputs for two tone testing of an SSB transmitter. One of these is at 800 Hz so is useful for evaluating CW filters. When laid out properly, it might fit onto a 50 x 80 mm PCB, cost about £24 including 3 switches (var/800/2tone, H/M/L freq range, H/M/L level), with two pots for var freq control and output level. If anybody would like such a device, let me know and I will tidy up my ugly bird's nest! Tim G3PCJ

Tips

Paul Tuton, as a reluctant 'PCB front panel man'!, asks about how to drill clean large circular holes in PCB material for control shafts etc.. The best approach is to use a pillar drill with the PCB material clamped firmly in place to the base of the drill stand just near the desired position of the hole - ontop of a piece of wood. Drill through first with a small pilot bit, then change to the desired size, with a sharp bit using medium speed. Advance it slowly into the material especially as it just breaks through on the underside of the PCB.

Paul also suggest the use of a generous blob of 'blue tack' as a means of holding components in place after insertion into the PCB holes, so that they stay in place when turned over for soldering.

Somerset Homebrew Contest

Peter Barville G3XJS has again kindly agreed to run this contest for the GQRP Club. The objective is to encourage the use of home-made gear - especially in contests. The detailed rules are in Sprat but it is essentially the same as last year. Either or both TX or RX need to be home built. A £50 voucher from Waxford Electronics awaits the winner. Any mode on 40 or 80m between 0900Z and 1200Z on Mar 25 2001. Beware clocks change the night before! Scoring favours two way QRP contacts but can be QRP/QRO! Somerset Range rigs often feature in the submitted logs but I emphasize that it is completely open for any brand of kit or other source! Full details in Sprat.

Minehead TCVR

In conjunction with Michael Morley, I have been trying out an alternative TX matching arrangement which I think leads to a better balance between TX and RX tuning. Please contact me if you would like to try this alternative approach. Tim G3PCJ.

Thanks! Finally, I must say that it has been a pleasure not to have to generate so much material myself this time! Thank you very much to all contributors and please keep it coming! Tim.